DOCUMENT RESUME

ED 279 500 SE 047 765

TITLE	Priorities, Partnerships, and Plans: Chemistry Education in the Schools. Final Report of the ACS 1984 Chemistry Education Planning Conference (College Park, Maryland, June 1-3, 1984).
INSTITUTION	American Chemical Society, Washington, D.C.
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	Oct 84
GRANT	OSA-8470372
NOTE	15p.
AVAILABLE FROM	American Chemical Society, Education Division, 1155 Sixteenth St., NW, Washington, DC 20036.
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Chemistry; *Elementary School Science; Elementary Secondary Education; Inservice Teacher Education; Instructional Improvement; Preservice Teacher Education; *School Community Relationship; Science Education; *Science Instruction; *Science Teachers; *Secondary School Science; Teacher Administrator Relationship; Teacher Evaluation; Teacher Improvement
IDENTIFIERS	*American Chemical Society

ABSTRACT

Participants in the Chemistry Education Planning Conference analyzed recent information documenting the many problems facing precollege science education. This document represents the final report of the conference sponsored by the American Chemical Society (ACS). An overview of the conference is provided along with its initial goals. The problem areas determined by the conference participants were: (1) the preservice and inservice education of teachers; (2) the assessment of teacher competence and student achievement; (3) the content of the curriculum; and (4) environmental factors related to science teaching. For each of these areas specific recommendations were developed. Included are the general conclusions of the conference. They urge that strengthening the teaching of science at the elementary level deserves the most immediate attention. In addition it is recommended that science educators do more to develop community support for science education, that inservice and preservice science teacher education be strengthened, and that teachers should be given more time for preparation. The document also contains a bibliography and a list of the conference participants. (TW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

PRIORITIES, PARTNERSHIPS, AND PLANS: CHEMISTRY EDUCATION IN THE SCHOOLS

The Final Report of the ACS 1984 Chemistry Education Planning Conference

ED279500

SE 047 765

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Jerry G. Bertenshaw

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Cover Photos:
National Science Teachers Association, Roger Wall

PRIORITIES, PARTNERSHIPS, AND PLANS: CHEMISTRY EDUCATION IN THE SCHOOLS

The Final Report of the 1984
Chemistry Education
Planning Conference
Sponsored by the
American Chemical Society
Supported by a Grant from the
National Science Foundation

Conference Chairs:
Alan L. McClelland,
E.I. du Pont de Nemours and Company
Marjorie H. Gardner,
The Lawrence Hall of Science

Conference Manager/Editor:
Sylvia A. Ware,
American Chemical Society

University of Maryland
College Park
June 1-3, 1984

CONTENTS

Executive Summary	3
Conference Overview	4
General Conclusions	6
Specific Action Plans	7
Bibliography	11
Participants	12

Supported by NSF Grant No. OSA-8470372

James Potter

EXECUTIVE SUMMARY

Participants in the Chemistry Education Planning Conference held at the University of Maryland on June 1-3, 1984 analyzed recent information documenting the many problems facing precollege science education. This analysis led to identification of priority areas requiring immediate action. The key conclusions were as follows:

- Though all levels of precollege science education are of equal importance, strengthening the teaching of science at the elementary level deserves the most immediate attention.
- Science educators should make greater efforts to develop community support for science education and to forge alliances of mutual concern with school administrators—from superintendents to principals to school board members.
- Since school science education can only be improved through the classroom teacher, support of the teacher needs to be strongly reinforced. This can be accomplished through: better preservice teacher education; expanded inservice training opportunities and programs; development of new resource materials; and, a clearer definition of appropriate, integrated science course content. Most importantly, teachers must be given the time necessary to prepare to teach well.

The consensus that elementary science education should receive priority attention was unexpected, but especially significant because only a small proportion of the Conference participants were directly involved with elementary teaching. This conclusion recognizes: the importance of the early introduction of science topics; the breadth of material those topics should cover; the challenge to the teacher to present an inter-disciplinary perspective at that level; and the opportunity offered to stimulate and develop the inherent curiosity of young children.

Reports from participating teachers stressed the need for time to prepare for demonstrations, experiments, and projects as well as the need to obtain more appropriate materials and supplies for such activities. Such needs cannot be met without the active support of principals, science coordinators, and, ultimately, school board members. The importance of working at the local district level, though with some Federal support for pilot projects, was recognized as essential to success since most school decisions are made at that level.

The need to provide strong support to the teacher was a recurring theme. For those teachers already in their active careers, good inservice training programs were considered the single most important support device. While these programs should be specifically tailored to the teacher's individual requirements and environment, some form of inservice training was judged important at all grade levels. The need to improve the subject matter competence of future science teachers was also seen as an imperative. It was recognized that this would require college and university science professors to restructure science courses for nonscience majors. Definition of precollege science course content, and development of curriculum materials were recognized as important tasks that should only be attempted with the full participation of experienced teachers.

Conference participants were fully cognizant that the many problems of precollege science education have been well documented by numerous studies. They declared that it was time to initiate practical, effective steps towards solutions. The hope of all at the Conference was that the recommendations put forward in this report will contribute to the development of those solutions.

"Science should be considered the fourth 'R'—as in reading, 'riting, 'rithmetic, and reasoning."

CONFERENCE OVERVIEW

The 1984 Chemistry Education Planning Conference of the American Chemical Society was held June 1-3 on the College Park campus of the University of Maryland. The event was supported by a joint grant from the Directorates for Science and Engineering Education and the Mathematical and Physical Sciences of the National Science Foundation.

The precarious state of science education in the schools of America has been well documented during the past several years in numerous comprehensive reports commissioned by the Federal Government and others. The Society has itself just completed a major study of the state of chemistry education in this country, and has held numerous conferences, meetings, and surveys to develop base-line data upon which to plan future programs at the precollege level (see Bibliography). The Society did not intend, in holding this conference, to rework familiar ground but to develop specific action plans to address previously formulated recommendations of special interest to the chemistry community. It was also hoped that the conferees would discuss ways to stimulate the most creative minds of this community—teachers, administrators, supervisors, researchers, academics and industrialists—to participate in attacking the most pressing problems now afflicting chemistry and science education at the precollege level.

The specific goals of the Conference were to:

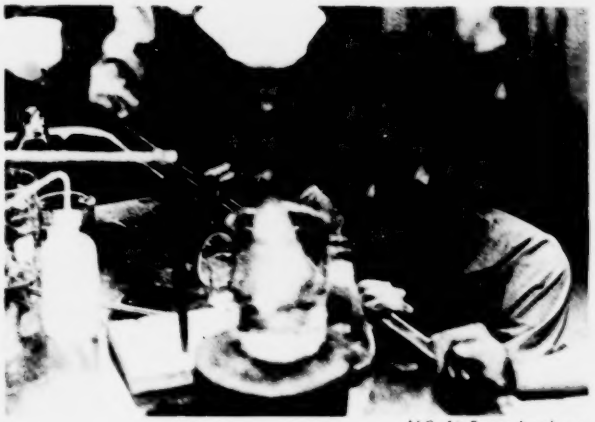
- Determine from existing data how the chemistry community might best utilize its resources and expertise to help solve some of the many problems identified.
- Suggest priorities for the chemistry community's involvement in education to prevent either duplication or dilution of efforts.
- Develop strategies to translate recommendations into specific action plans.

The 39 conference participants were selected to represent the entire spectrum of individuals with responsibilities in the precollege chemistry arena: classroom teachers, local and state science supervisors, chemistry educators, college and university professors of chemistry, industrialists, and ACS staff. Although some of the participants were familiar with the Society and its programs, many were not. Thus, prior to the meeting, conferees were asked to read a range of background materials (see Bibliography) to make certain that all came with a similar factual base from which to proceed.

The first planning session on the Friday morning was chaired by Dr. Alan McClelland, Chair of the ACS Society Committee on Education and Assistant to the Director of the Central Research and Development Department at E.I. du Pont de Nemours and Company. In his welcoming remarks, Dr. McClelland characterized the task before the group as similar to selecting a meal from an extensive menu in a good restaurant. He emphasized the point that the "menu," i.e., the main recommendations from which the participants were to select, had already been determined, but that the selection of the "meal," i.e., the priorities for immediate action, was to be determined by the conferees. He also made it quite clear that the intent of the Conference was to move forward into new territory rather than to rediscover old, though perhaps valuable, ideas.

During the subsequent orientation session, officers from other professional societies addressed the Conference. Presenting descriptions of their precollege activities and resources already in place, and delineating future plans, were the Chief Education Officer of the American Association for the Advancement of Science (AAAS), Dr. James Rutherford; the Executive Director of the American Association of Physics Teachers (AAPT), Dr. Jack Wilson; and the President of the National Science Teachers Association (NSTA), Dr. Alice Moses. These presentations made clear that a large and reliable data base upon which to base action had already been developed. Programs to address many of the needs identified were in place, were creative in approach, and were achieving positive results. However, even greater efforts were needed to address the magnitude of the problems now facing precollege science education.

The group was then addressed by officials from the National Science Foundation: Dr. Laura Bautz, then Acting Assistant Director for Science and Engineering Education, and Dr. Henry Blount, a Program Director with the Chemistry Division. Dr. Bassam Shakhashiri, then Director of the Institute for Chemical Education, University of Wisconsin at Madison, and now NSF Assistant Director for Science and Engineering Education,



U.S. Air Force Academy

also spoke briefly.

These presentations were followed by reports from the Director of the ACS Education Division, Dr. Moses Passer; and the Head of ACS Educational Services, Ms. Sylvia Ware. Results of recent ACS studies were presented in some detail by Dr. Peter Yankwich, University of Illinois, the Chair of the ACS Task Force for the Study of Chemistry Education in the United States; and by Dr. Henry Heikkinen, University of Maryland, the Chair of the ACS Kindergarten through Ninth Grade Conference. Dr. Heikkinen also summarized findings from the ACS Division of Chemical Education's town meetings.

The orientation session clarified the scope of current activities in precollege chemistry in particular and science education in general, as well as identified areas where little had yet been accomplished. Many of the morning reports emphasized the role of the classroom teacher as an implementor of new programs and ideas, and were of particular interest to those attending who had little direct knowledge of the daily problems encountered at the precollege level of science education.

On Friday afternoon, Dr. Marjorie Gardner, the co-Chair of the Conference, and Chair of the ACS Division of Chemical Education, gave the charge to the group. Recollecting the "menu" analogy of the morning's session, she urged the participants to use the first discussion session to identify those priority areas in precollege education that they believed needed immediate attention.

Following this charge, the Conference was divided into three working groups that were heterogeneous in composition, i.e., each group included teachers, supervisors, professors, industrialists, ACS staff, and NSF observers.

On reporting back to the general meeting, it was clear that, though the avenues of approach were widely different, and despite the chemistry orientation of most participants, the reports of the three groups were centered around the same basic concern, namely the compelling need to upgrade elementary school education. Across the spectrum of precollege education, four particular problems were identified and assigned to the different working groups for further discussion and action recommendations. During the next day-and-a-half, the groups met separately and together in plenary sessions to discuss and refine the four areas and the action plans possible to help address problems in those areas.

The problem areas were defined as follows:

I Preservice and Inservice Education of Teachers

This included the training and continuing education of both elementary teachers and secondary school chemistry teachers through a variety of mechanisms. Particular emphasis was placed on alternative strategies for the continuing education of teachers including identification of the roles to be played by local authorities, colleges and universities, industry, professional associations including ACS, and the NSF.

II Assessment of Teacher Competence and Student Achievement

The need for assessing teacher qualifications and continuing performance in the classroom as well as for evaluating programs of instruction, were discussed in some detail. Also included were ways to assess the physical science/chemistry achievement of *all* students. Attention was given to the possibility of accrediting or approving high school chemistry programs.

III Curriculum Content

At the elementary school level, the quantity and quality of science instruction, especially in the physical sciences, was a major issue. At the junior high school level an "integrated disciplines" approach to the teaching of science was considered most appropriate; and, at the high school level, the need to provide a range of chemistry courses for different types of students came under intense discussion.

IV Environmental Factors Related to Science Teaching

These were broadly defined to include not only the school setting in which science learning takes place, but also the degree of administrative support and the climate in society at large that intluence the extent to which a community is willing to support improved science instruction in its schools. The lack of time available for such activities as planning lessons, preparing teaching materials, and professional growth, was singled out as the most critical environmental factor inhibiting excellent science teaching.

U.S. Air Force Academy

GENERAL CONCLUSIONS

As has been made clear previously, the Conference participants were an extremely knowledgeable and diverse body. Within the goals of the Conference, participants had an opportunity to set their own priorities and select their own agenda. The four problem areas identified emerged as a consensus declaration from the three working groups following their independent discussions. The surprise of the Conference, given the background of the participants, was the focus upon the need to improve elementary science education (defined as kindergarten through sixth grade). Whether discussing teacher preparation, student achievement, curricula, or the teaching environment, each working group examined ways in which these areas could be improved for elementary education. Certainly many problems at the junior and senior high school level were identified and discussed, but always conversation returned to elementary physical science education.

The group generally agreed that the task of teaching science in the elementary school should be the responsibility of the classroom teacher and not of a science specialist. The importance of integrating science activities into the regular classroom schedule could not be overemphasized. Science should be considered an essential component of a basic education—the fourth "R"—as in reading, 'riting, 'rithmetic, and reasoning!

Recognizing that elementary school teachers do not have the necessary training in science instruction (particularly in physical science) to be comfortable with its introduction into their classrooms, the conferees insisted that the preservice training of elementary teachers include an adequate exposure to a range of science courses. It was pointed out that several associations, including both AAAS and NSTA, had already developed guidelines for the preservice training of elementary teachers.

The group decided that one reason inadequate time and attention are devoted to science in the lower grades is the area is so poorly defined, resulting in inadequate instructional materials. What exactly is elementary science education? What should be taught and at which grade levels? At present, science education at the elementary level seems to focus upon biological and earth sciences and avoid physical science. This discussion led to the recommendation that an overall framework was badly needed to define both subject matter and specific activities in elementary science appropriate for each grade. This recommendation led to a broader consensus that such a framework is needed for all science education—from kindergarten through the first year of college. The group wanted this framework to produce continuity from one grade to the next and reacted positively to the concept of vertical articulation of curriculum. Lack of continuity in teaching/learning objectives was identified as a special problem at two particular interfaces: middle or junior high school/senior high school and high school/college.

The interdisciplinary nature of science in the earlier grades was seen as an opportunity for educators and scientists from different disciplines to cooperate in the development of new curricular materials for these grades. At the middle/junior high school level, there was agreement that the science taught should be integrated with technology and society topics. There was also a plea for the teaching of physical science (both chemistry and physics) to nonscience majors at the high school level. The group deplored the decreased emphasis on laboratory instruction in high school chemistry, calling for a greater use of demonstrations by the teacher and the development of new, safe experiments for the students.

Teachers present identified lack of time as a major factor impeding the delivery of effective science/chemistry instruction. The distribution of guidelines for the teaching of effective science/chemistry instruction (already developed by ACS and other societies) was seen as one way to bring the time issue before school administrators.

The idea of partnerships of various kinds surfaced in a number of contexts. School/industry, school/college, elementary school/high school partnerships were all viewed as mechanisms to assist classroom teachers at improving their subject matter competence and instructional delivery. Partnerships among teachers in the form of peer teacher inservice training were also considered useful.

There was recognition that many of the problems identified would have to be solved at the state and local

"All students should be given the opportunity to appreciate and value the scientific process and its accomplishments."

level by state and local school systems. However, other groups, including colleges, universities, business and industry, and local associations of scientists and engineers, should offer assistance as requested by the school systems. The chemistry research community should contribute its expertise to teacher training/retraining and curriculum development. Efforts in these areas should be organized at the local, regional, and national levels.

The group emphasized that, although the burden of responsibility weighs most heavily at the state and local levels, the Federal Government must also assume its share. The Conferees encouraged the National Science Foundation to consider funding a range of model programs throughout the country designed to upgrade the subject matter competence and technical skills of physical science teachers especially, though not exclusively, at the elementary level. These models should explore a range of novel continuing education delivery systems and be subject to a rigorous comparative evaluation of their effectiveness. NSF also should provide more support for a revitalized academic year and summer institute teacher training program for all grades of instruction. The concept of regional science centers established and funded by NSF was also strongly supported by the group. Finally, NSF was urged to consider funding an interdisciplinary effort that would develop the framework necessary to provide coherence and continuity to the teaching of science from kindergarten through 12th grade.

SPECIFIC ACTION PLANS

In a society such as ours, where science and its application as technology have a profound influence on the quality and duration of our lives, we must all be concerned that as many students as possible have an opportunity to appreciate and value the scientific process and its accomplishments. Clearly, many individuals, groups, and sectors of the education community are responsible for making certain that such important instruction takes place.

Thus, participants in this Conference were encouraged not only to suggest specific action plans in the four problem areas but also to identify those groups to whom the recommendations should most properly be addressed. Since the Conference was organized by ACS with financial support from the NSF, it is hardly surprising that many of the recommendations were addressed to these two groups. However, the conferees recognized that science at the elementary and middle school level is essentially of an interdisciplinary nature. They determined that action plans addressing problems at these levels could most properly be implemented through cooperation among the disciplines. Thus, some recommendations call for cooperative action involving a number of societies concerned with the teaching of precollege science.

Finally, though most importantly, conferees emphasized the central responsibility of state and local education authorities to implement the majority of the action plans suggested. The group encouraged the professional science societies to be as supportive of local efforts as possible, and challenged the ACS, as organizer of the Conference, to accept the responsibilities of (i) disseminating the recommendations of the Conference as widely as possible, and (ii) taking steps to ensure that many of these action plans are developed into working programs at both the local and national levels.

I Preservice and Inservice Education of Teachers

We most urgently recommend:

a) that schools of education be encouraged to include laboratory-based subject matter preparation in both the biological and physical sciences in their curricula for students of education.

b) that AAAS and NSTA reexamine and, if necessary, revise their current guidelines for the preparation of elementary teachers, and distribute revised guidelines to schools of education, and to state and local education authorities.

c) that school districts be encouraged and assisted to accept primary responsibility for developing and creating effective ongoing inservice teacher training programs for both elementary and secondary school science teachers. These programs should utilize content determined by the district teachers and supervisors and be based upon locally approved curricula. Local scientists should

James Potter

be invited to participate in clarifying the content of courses and developing instructional materials and experiences. Master teachers at all grade levels should be used to conduct inservice programs for their peers. All teachers should be required to attend these inservice activities.

d) that school districts commit funds to the development of new models of inservice education for science teachers as well as seek financial support from local, state, and national sources.

e) that colleges and universities across the nation be encouraged to develop partnerships with local schools designed to upgrade the subject matter competence of science teachers at all levels of precollege education. Such partnerships should be supported by a competitive, cost-sharing grant program administered by the National Science Foundation.

f) that business and industry play a role in the inservice education of local precollege science teachers. This role should include the routine hiring of secondary school chemistry teachers for meaningful summer employment to provide educational growth opportunities for the teacher, as well as much needed income. Industry also should consider funding summer programs for teacher training analogous to the four-week summer institutes in chemistry funded by the Dreyfus Foundation. The adopt-a-school partnership was viewed as yet another important way for business and industry to support science education in the local community.

g) that programs permitting early retirees from industry to obtain the educational credits necessary to teach chemistry in the high school classroom be designed by colleges of education. These retirees were viewed as a very valuable but untapped solution to the immediate problem of the shortage of qualified chemistry teachers. The NSF should make funds available to support this type of program in any feasible manner.

h) that the ACS Office of High School Chemistry provide a listing of "workshop facilitators" (i.e., chemistry teachers qualified to conduct inservice workshops) to school districts as a resource to enhance the chemistry component of inservice training.

i) that the ACS, on an experimental basis, initiate efforts to combine its capabilities in non-traditional education delivery systems, such as teleconferencing, with the expertise of groups such as NSTA, to develop courses for inservice training. Such courses could be held, on a regular basis, at local colleges and universities.

j) that the ACS Division of Chemical Education organize programs in physical science for elementary teachers at ACS national and regional meetings. ACS should be asked to waive the one-day registration fee for K-9 teachers who attend these programs.

k) that the NSF, through its Directorate for Science and Engineering Education, encourage and fund proposals for teacher training institutes. Past institutes were a most effective mechanism for teachers to acquire skills, knowledge, and positive attitudes through formal presentations and collegial interactions.

l) that the NSF consider funding a range of model inservice training programs for science teachers at all levels to determine both the most effective and cost-efficient ways to deliver inservice education to teachers.

II Assessment of Teacher Competence and Student Achievement

We most urgently recommend:

a) that ACS local sections support the implementation of teacher self-assessment guidelines for elementary and secondary school science that have been developed by NSTA.

b) that ACS develop guidelines for assessing teacher competence in high school chemistry, and that other associations develop similar guidelines for assessing performance in their own disciplines. Instructors who continue to teach science and who meet appropriate preservice and continuing education requirements (such as the AAAS, NSTA, AAPT, and ACS guidelines) should be subject to no additional requirements for demonstrating subject matter competence.

c) that ACS consider ways of structuring a program

"We need to develop a curriculum framework for science education that starts at kindergarten and develops coherently through 12th grade."

of high school assessment (possibly through the ACS local sections) designed to evaluate chemistry programs in terms of teacher performance, course content, adequacy of equipment and materials, facilities, and time for instruction and preparation. Any initiatives of the ACS in this area should be made in cooperation with existing regional and state accreditation organizations (such as the North Central Accrediting Association).

d) that the ACS Division of Chemical Education take steps to produce competency test-item "banks" for use by state and local authorities developing their own chemistry achievement tests for students. These test items should couple assessment with specific learning expectations and should aim at testing general reasoning ability rather than narrow subject matter recall.

e) that criteria be developed by a consortium of science and science education societies to design and/or select appropriate assessment instruments to evaluate the science achievement of all precollege students at periodic intervals from kindergarten through 12th grade.

III Content of Curriculum

We most urgently recommend:

a) that a consortium of educators from elementary and secondary schools, universities and colleges, and state and local school administrations be convened, under funding from NSF, to begin work on a curriculum framework defining the scope of school science from kindergarten through 12th grade. Such a framework should include the major concepts to be developed in the content areas for each grade level, or for grade level blocks (e.g., K-3, 4-6, 7-9) where most appropriate. The framework also should allow for the development of a variety of organizational schemes including a spiral curriculum that reinforces and builds on skills from one year to the next. The consortium should examine current and emerging state curriculum frameworks and provide a sense of direction for a wide range of curriculum development agencies. This is *not* a call for a national curriculum, but it is a plea for a curriculum framework that starts at kindergarten and develops coherently through the precollege levels.

b) that all interested parties, but especially the ACS, develop teaching units and materials in the physical sciences (including chemistry) for grades K-6. These materials should feature:
   - experiments, "investigations," and activities that emphasize physical science and the processes of science.
   - experiences that help students develop appropriate concepts of physical science as applied to daily life.
   - integration of physical science with other components of the curriculum.
   - resources and implementation materials for teacher use.

c) that elementary school teachers should be included in all phases of planning, preparation, use, and evaluation of curriculum materials. Professional chemists and secondary school chemistry teachers, along with their counterparts in the other physical sciences, should also participate in this process. It is important that the materials produced be compatible with existing models for science instruction developed by key state departments of education, and by various other organizations, agencies, and conferences.

d) that ACS, together with other associations including AAAS, NSTA, AAPT, develop materials for use in physical science classes at the middle/junior high school level. These materials should incorporate a variety of strategies including the project approach, integration of concepts across disciplines, and vertical articulation. A laboratory emphasis is essential, coupled with an awareness of the type of material appropriate for the students' level of intellectual development. Suitable computer software should be part of the curriculum packages developed.

e) that the ACS Division of Chemical Education, working with other appropriate groups, re-establish a curriculum committee with a view toward defining the appropriate content of a range of secondary school chemistry courses, including a

"We must develop partnerships across disciplines and between all groups concerned if we are to improve science education in any meaningful fashion."

course for students who do not intend to major in science at college.

IV Environmental Factors Related to Science Teaching

We most urgently recommend:

a) that the ACS Board of Directors be asked to support the establishment of a permanent staff Office of Elementary Science Education to coordinate ACS efforts at this level, to work in concert with other organizations, and to devise new strategies for addressing the problems of elementary science education.

b) that as many as ten regional science centers be established and funded by the National Science Foundation to provide teachers with the support they need. The centers, staffed by a small multidisciplinary team of specialists, could help conserve time for the teachers by providing expert help when needed; developing new materials, experiments, and demonstrations for the classroom; and offering in-service workshops directed to the specific needs of the communities they serve.

c) that the ACS Society Committee on Education establish a task force to investigate the feasibility of evaluating and disseminating existing quantitative data on science teaching in the nation's schools related to the adequacy of instructional and preparation time, facilities, equipment and supplies, paraprofessional help, administrative support, and teacher certification. If such an analysis identifies gaps in the statistical record, then the Committee should expand its charge to include the gathering of new data.

d) that the ACS and the NSF continue high-level support of programs that promote the public understanding of science. The social milieu in which science is taught determines the extent to which society will support the funding of expanded science education programs.

e) that the ACS Department of Educational Services working with the Department of Public Relations explore ways to contribute articles on scientific topics to periodicals such as "My Weekly Reader" and similiar publications that reach children in the classroom.

f) that the NSF fund innovative efforts to develop new interactive exhibits or media presentations in chemistry, a notable area of weakness in the informal education system that reaches both children and adults.

These recommendations suggest a multitude of opportunities for many individuals and concerned groups to come together and take specific actions to address the needs identified during the Conference. However, the group recognized that merely bringing the results of this Conference to the attention of the parties interested was not sufficient to ensure their implementation. Therefore, it was recommended that the American Chemical Society, through its activities to implement the recommendations of the ACS Task Force for the Study of Chemistry in the United States, accept the responsibility for ensuring that these recommendations be acted upon and, where appropriate, establish partnerships with other groups to do so.

U.S. Air Force Academy

BIBLIOGRAPHY

American Association for the Advancement of Science. "Education in the Sciences: A Developing Crisis." Washington, DC: American Association for the Advancement of Science, 1982.

American Chemical Society. "Chemistry in the Kindergarten-through-Ninth-Grade Curricula: Report with Recommendations." A Final Report of the 1982 Invitational Education Workshop. Washington, DC: American Chemical Society, 1983.

American Chemical Society. "Guidelines and Recommendations for the Preparation and Continuing Education of Secondary School Teachers of Chemistry." Washington, DC: American Chemical Society, 1977.

American Chemical Society. "Tomorrow: A Final Report of the Task Force for the Study of Chemistry Education in the United States." Washington, DC: American Chemical Society, October 1984.

Bent, Henry. "What Thermodynamics Says About Science-Related Matters." Personal Communication. Department of Chemistry, North Carolina State University, May 15, 1984.

Boyer, Ernest L. *High School. A Report on Secondary Education in America.* New York, NY: Harper & Row, 1983.

California State Curriculum Framework and Criteria Committee for Science. "Science Framework for California Public Schools: Kindergarten and Grades One Through Twelve: 1984 Addendum to 1978 Report." Sacramento, CA: State Department of Education, 1984.

Committee on Science and Mathematics Education. "Recommendations for Improving the Quality of Science and Mathematics Education in North Carolina's Public Schools." Raleigh, NC: Office of the Governor, 1982.

Fairfax County Public Schools. "Science, Program of Studies: 7-12." Fairfax, VA: School Board of Fairfax County, 1978.

Gardner, Marjorie. "K-8 Town Meeting: A Preliminary Report." Department of Chemistry, University of Maryland, College Park, May 1984. Photocopy.

Harms, N.C.; Kahl, S.R. *The Status and Needs of PreCollege Science Education: Report on Project Synthesis.* Final Report to NSF for Grant SED 77-19001. Washington, DC: National Science Foundation, 1981.

Mechling, K.R. "Recommended Standards for the Preparation and Certification of Teachers of Science at the Elementary, Middle/Junior High School." *Science and Children,* September 1983.

National Commission on Excellence in Education. *A Nation at Risk: The Imperative for Educational Reform.* Washington, DC: U.S. Department of Education, 1983.

National Science Board Commission on Precollege Education in Mathematics, Science and Technology. *Educating Americans for the 21st Century.* Washington, DC: National Science Foundation, 1983.

Office of Science and Engineering Personnel and Education. *Science and Engineering Education: Data and Information.* NSF 82-30. Washington, DC: National Science Foundation, 1982.

Task Force on Education for Economic Growth. "Action for Excellence." Denver, CO: Education Commission of the States, June 1983.

Twentieth Century Fund Task Force on Federal Elementary and Secondary Education Policy. *Making the Grade.* New York, NY: Twentieth Century Fund, 1983.

PARTICIPANTS

Dr. Martin Ackerman
Department of Chemistry
Oberlin College
Oberlin, OH 44074

Dr. Laura Bautz
Director, Division of Astronomical Sciences
Directorate for Astronomical, Atmospheric, Earth, and Ocean Sciences
National Science Foundation
Washington, DC 20550

Ms. Lynda Beck
Assistant Principal
Phillips Exeter Academy
Exeter, NH 03833

Dr. Henry Bent
Department of Chemistry
North Carolina State University
Raleigh, NC 27607

Dr. Henry Blount
Program Director, Chemistry Div.
Directorate for Mathematical and Physical Sciences
National Science Foundation
Washington, DC 20550

Dr. Glenn Crosby
Department of Chemistry
Washington State University
Pullman, WA 99164

Mr. David Daniel
Office of High School Chemistry
American Chemical Society
1155 16th Street, N.W.
Washington, DC 20036

Dr. James DeRose
238 Kent Road
Springfield, VA 19064

Mr. Edmund Escudero
St. John's School
2401 Claremont Lane
Houston, TX 77019

Dr. Dwaine Eubanks
University Center of Effective Instruction
Oklahoma State University
Stillwater, OK 74078

Dr. Joseph Exline
Associate Director for Science Education
Commonwealth of Virginia
Box 6Q
Richmond, VA 23216

Dr. Ellis Fields
Research Consultant
Amoco Chemical Corporation
Research and Development
P.O. Box 400
Naperville, IL 60540

Dr. Dorothy Gabel
School of Education
Indiana University
Bloomington, IN 47405

***Dr. Marjorie Gardner**
Lawrence Hall of Science
University of California at Berkeley
Berkeley, CA 97420

***Dr. Henry Heikkinen**
Department of Chemistry
University of Maryland
College Park, MD 20742

Dr. David Hercules
Department of Chemistry
University of Pittsburgh
Pittsburgh, PA 15261

Dr. Jack Higham
Bureau of Science Education
State Department of Education
Albany, NY 12234

†Ms. Mary Beth Key
3900 Watson Place, N.W.
Washington, DC 20016

****Dr. Stanley Kirschner**
Department of Chemistry
247 Life Sciences Building
Wayne State University
Detroit, MI 48202

Dr. John Layman
Department of Physics
University of Maryland
College Park, MD 20742

Dr. Thomas Lippincott
Institute for Chemical Education
Department of Chemistry
University of Wisconsin-Madison
Madison, WI 53706

Dr. Paul Mazzochi
Department of Chemistry
University of Maryland
College Park, MD 20742

***Dr. Alan McClelland**
E. I. du Pont de Nemours & Co.
CR&D Department
Wilmington, DE 19898

***Dr. Lillian McDermott,**
Director, Division of Materials Development and Research
Directorate for Science and Engineering Education
National Science Foundation
Washington, DC 20550

†Dr. Richard Merrill
Curriculum Specialist
Mt. Diablo School District
Concord, CA 94519

Dr. John Moore
Department of Chemistry
Eastern Michigan University
Ypsilanti, MI 48197

***Dr. Alice Moses**
Laboratory School
University of Chicago
1362 East 59th Street
Chicago, IL 60639

Dr. Robert Parry
Department of Chemistry
University of Utah
Salt Lake City, UT 84112

***Dr. Moses Passer**
Education Division
American Chemical Society
1155 16th Street, N.W.
Washington, DC 20036

Dr. Harold Pratt
Science Coordinator
Jefferson County Schools
1209 Quail Road
Lakewood, CO 80215

Dr. Joseph Premo
Science Consultant
Minneapolis Public Schools
807 NW Broadway
Minneapolis, MN 55413

Dr. Theodore Reid
Division of Teacher Enhancement and Informal Science Education
Directorate for Science and Engineering Education
National Science Foundation
Washington, DC 20550

***Dr. James Rutherford**
American Association for the Advancement of Science
1776 Mass. Ave., N.W.
Washington, DC 20036

Dr. Mary Ann Ryan
Division of Materials Development and Research
Directorate for Science and Engineering Education
National Science Foundation
Washington, DC 20550

Dr. David Samuel
47 Eastgate Lane
Hamden, CT 06517
(Visiting Professor, Yale University)

****Ms. Ethel Schultz**
Marblehead High School
Marblehead, MA 01945

****Dr. Truman Schwartz**
Department of Chemistry
Macalaster College
St. Paul, MN 05551

***Dr. Bassam Shakhashiri**
Assistant Director for Science and Engineering Education
National Science Foundation
Washington, DC 20550

Ms. Patricia Smith
Air Force Academy High School
U.S. Air Force Academy
Colorado Springs, CO 80840

Dr. Herbert Strauss
Department of Chemistry
University of California at Berkeley
Berkeley, CA 97420

Dr. Raymond Theiss
Oregon Department of Education
700 Pringle Parkway
Salem, OR 97310

Ms. Gloria Tucker
Ann Beers Elementary School
Alabama Avenue, S.E.
Washington, DC 20001

***Ms. Sylvia Ware**
Educational Services
American Chemical Society
1155 16th Street, N.W.
Washington, DC 20036

Dr. Edel Wasserman
Associate Director-Technology
Chemical Sciences Dept.
E.I. du Pont de Nemours & Co.
Wilmington, DE 19898

***Dr. Robert Watson,**
Head, Office of College Science Instrumentation
Directorate for Science and Engineering Education
National Science Foundation
Washington, DC 20550

†Dr. Kenneth Whitten
Department of Chemistry
University of Georgia
Athens, GA 30602

***Dr. Jack Wilson**
Department of Physics
University of Maryland
College Park, MD 20742

***Dr. Peter Yankwich**
University of Illinois
Box 2, Noyes Laboratory
505 S. Mathews Avenue
Urbana, IL 61801

*Plenary Speaker
**Discussion Group Leader
†Discussion Group Reporter

Education Division
American Chemical Society
1155 Sixteenth Street, N.W.
Washington, DC 20036

October 1984